REMARKS

AMENDMENTS

In the amendments above, Claims 1, 3-16, 18-26, and 28 have been amended, and new Claims 29 to 34 have been added, to more particularly point out and distinctly claim Applicant's invention.

DRAWING OBJECTION

The drawings have been objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the reference signs 34 and 50. The Examiner's attention is directed to the two replacement sheets of Figures 1 to 3 attached hereto where elements "30", "34", and "50" have been identified. It is believed that the objections to the drawings have been overcome.

OBJECTION TO THE DISCLOSURE

The disclosure has been objected to because of informalities in Paragraphs 11 and 34. The Examiner's attention is directed to the amendments above, where Paragraphs 11, 34, and 61 have been amended. It is believed that the objections to the disclosure have been overcome.

OBJECTIONS TO THE CLAIMS

Claims 3, 4, 11, 18, and 19 have been objected to. The Examiner's attention is directed to the amendments above, where the Examiner's objections are believed to have been overcome.

REJECTIONS UNDER 35 U.S.C. §112

Claims 6, 7, 13, 14, and 20 have been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. The Examiner's attention is directed to the amendments above, where the Examiner's rejections of the claims under § 112 are believed to have been overcome.

REJECTION UNDER 35 U.S.C. § 102(b)

Claims 1-21 and 25-27 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Onishi et al., U.S. Patent No. 5,134,334 ("Onishi"). The Examiner maintains that with respect to Claim 1, Onishi discloses a device (Fig. 1) comprising: a flexible substrate (item 3) having at least one flat or substantially flat surface (Fig. 1), and a source of vibrational energy (items 6 and 7) that can be applied to said substrate (Figs. 6a-6h), wherein the device is capable of translational motion along a surface (Column 4, lines 31-61); that with respect to Claim 2, Onishi discloses the device of Claim 1, wherein the vibrational energy is harmonic; that with respect to Claim 3, Onishi discloses the device of Claim 2, wherein the vibrational energy causes the substrate to flex in a harmonic fashion; that with respect to Claim 4, Onishi discloses the device of Claim 2, wherein the source of harmonic vibration imparts vibrations to said substrate to cause said substrate to move in a translational fashion; that with respect to Claim 5, Onishi discloses the device of Claim 1 which can adhere to a surface other than horizontal; that the device of Onishi could adhere to surfaces that are slightly off horizontal, with at least friction keeping the device adhered to the surface; that with respect to Claim 6, Onishi discloses the device of Claim 5, wherein the surface is vertical; that with respect to Claim 7, Onishi discloses the device of Claim 5, wherein the surface is upside down; that with respect to Claim 8, Onishi discloses the device of Claim 1, wherein a change in the

frequency of the vibrational energy causes the direction of the motion of the device to change; that with respect to Claim 9 Onishi discloses the device of claim 1, wherein the vibrational energy is imparted to the substrate to cause the device to adhere to the surface; that with respect to Claim 10, Onishi discloses a device capable of translational motion comprising: a flexible substrate having at least one flat or substantially flat surface; and a source of harmonic vibration in communication with said substrate; that with respect to Claim 11, Onishi discloses the device of Claim 10, wherein the source of harmonic vibrations imparts vibrations to said substrate to cause said substrate to move in a translational fashion; that with respect to Claim 12, Onishi discloses the device of Claim 10 which can adhere to a surface other than horizontal; that the device of Onishi could adhere to surfaces that are slightly off horizontal, with at least friction keeping the device adhered to the surface; that with respect to Claim 13, Onishi discloses the device of Claim 12, wherein the surface is vertical; that with respect to Claim 14, Onishi discloses the device of Claim 12, wherein the surface is upside down; that with respect to Claim 15 Onishi discloses the device of Claim 10, wherein the source of harmonic vibration is attaches to the substrate; that with respect to Claim 16, Onishi discloses a device comprising: a flexible substrate or surface; and a source of vibrational energy that can be applied to said substrate or surface, wherein the device is capable of translational motion along a surface or through a fluid; that with respect to Claim 17, Onishi discloses the device of Claim 16, wherein the vibration energy is harmonic; that with respect to Claim 18, Onishi discloses the device of Claim 17, wherein the vibrational energy causes the substrate or surface to flex in a harmonic fashion; that with respect to Claim 19, Onishi discloses the device of Claim 17, wherein the source of harmonic vibration imparts vibrations to said substrate or surface to cause said device to move in a translational fashion; that with respect to Claim 20, Onishi discloses the device of Claim 16 which can adhere to a surface other than horizontal; that the device of Onishi could adhere to surfaces that are slightly off horizontal, with at least friction keeping the device

adhered to the surface; and that with respect to Claim 21, Onishi discloses the device of Claim 16 wherein a change in the frequency of the vibrational energy causes the direction of the motion of the device to change.

The Examiner also maintains that with respect to Claim 25, Onishi discloses a method for imparting translational motion to an object on a surface or in a fluid, said method comprising the steps of: (a) vibrating the object to produce harmonic motion; (b) coupling the vibration to the surface or fluid in an asymmetrical way to produce translational motion by the object; that with respect to Claim 26, Onishi a method for imparting translational motion to an object having a substrate on a first surface on a second surface or in a fluid, said method comprising the steps of: (a) applying vibrational energy to the object to produce harmonic vibrations in the substrate or first surface coupling the vibrations to the second surface in an asymmetric way to produce translation motion by the object; that with respect to Claim 27, Onishi discloses the method of Claim 26, wherein a force in one direction during one part of the wave cycle is not counterbalanced by an equal and opposition force in the other direction; and that, in addition, because the device of Onishi moves translationally, the forces must be unbalanced.

REJECTION UNDER 35 U.S.C. § 103(a)

Claims 22-24 and 28 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Onishi in view of Culp, U.S. Patent No. 5,350,966 ("Culp"). The Examiner maintains that with respect to Claim 22, Onishi discloses the device of Claims 1, 10, and 16; that Onishi does not disclose expressly an antisymmetry element; that Culp teaches a piezoelectric device with antisymmetric elements; and that at the time of invention, it would have been obvious to a person of ordinary skill in the art to combine

the antisymmetric elements of Culp with the device of Onishi for the benefit of augmenting the propulsive effects.

The Examiner also maintains that with respect to Claim 23, the combination of Onishi and Culp discloses the device of Claim 22; that Culp discloses that the antisymmetry element comprises bristles, spines or spicules embedded in a flexible matrix, regular or irregular projections, fins, or a conformable mat; that with respect to Claim 24, the combination of Onishi and Culp discloses the device of Claim 23; that Culp discloses that the antisymmetry element comprises bristles; that with respect to Claim 28, Onishi discloses the method of Claims 25 and 26; that Onishi produces a net force in one direction when averaged over the entire vibratory cycle; that additionally, because the device of Onishi moves translationally, there must be an average net force; that Onishi does not disclose expressly an antisymmetry element; that Culp teaches a piezoelectric device with antisymmetric elements; and that, at the time of invention, it would have been obvious to a person of ordinary skill in the art to combine the antisymmetric elements of Culp with the device of Onishi for the benefit of augmenting the propulsive effects.

DISCUSSION

Applicant respectfully traverses the above rejections.

According to an aspect of the invention described and claimed herein, vibratory motion is used to perform the functions of devices described herein, namely, to move along a level surface, to climb up a smooth vertical or slanted wall, to move upside down on a ceiling, or to climb up a hollow tube. Another aspect of the invention comprises a solution to the problem of controlling the direction of such moving devices. Without directional control, the utility of a moving device is much reduced; and, with directional control, it becomes possible to build devices which can be used for exploration of

intricate spaces, under either remote control or control based on an on-board set of sensors and decision-making circuits.

A great advantage of vibratory or harmonic propulsion is that such devices may be very small and simple compared to more conventional devices, such as wheeled devices. This is because this form of propulsion does not require axles, bearings, transmissions, or even wheels, as are needed for wheeled devices. The present invention requires a system with a source of vibrations and a driving surface, which comes in contact with the surface upon which the device is moving.

In one embodiment of the invention, a device comprises a flexible substrate having at least one substantially flat surface and a source of vibrational energy attached to or in communication with at least one substantially flat surface to apply vibrational energy to the flexible substrate. The vibrational energy causes harmonic or periodic motion in the flexible substrate to cause the device to adhere to an additional surface, and the device is capable of translational motion along the additional surface. In another embodiment of the invention, the flexible substrate has first and second substantially parallel planar surfaces.

In its simplicity and with few moving parts, the present invention overcomes the problems of the prior art. The present invention describes a device and method to cause an object to move translationally by impartation of vibrational energy.

One embodiment of the invention is generally directed to imparting translational motion of an object by application of vibrations, preferably harmonic vibrations. Another embodiment of the invention is a device to effect translational motion that comprises a source of harmonic or periodic mechanical or acoustic vibrations, a vibrating surface whose modes of vibration are excited by the source of vibrations, and a symmetry breaking element. A further embodiment of the invention concerns a method to effect

translational motional comprising the steps of applying harmonic or periodic vibration to an object, exciting modes of vibration in a surface, and directing the translational motion of the object by using symmetry breaking elements. The present invention specifically discloses types of vibration sources, types of vibrating surfaces, and types of antisymmetry elements.

Other embodiments of the present invention include methods to effect translational motion from traveling waves, translational motion from standing waves, wall climbing motion, directional control using vibrating surfaces ("focusing surfaces") which interact with obstacles, and directional control using eigenmodes.

Applicant's invention is not disclosed or suggested by Onishi or Culp. Onishi describes an ultrasonic linear motor having one or more legs where piezoelectric elements are mounted on surfaces that are at an angle to a leg. The legs are vibrated and move through grooves in a surface upon which the motor sits.

There are significant differences between what Onishi teaches and Applicant's invention. First, Applicant's device in one embodiment comprises a flexible substrate having at least one substantially flat surface where vibratory energy is transmitted to at least one such surface. And second, the flexible substrate adheres to an additional surface, such as a table top, vertical wall, or ceiling. The device taught by Onishi does not, among other things, adhere to a surface. Onishi does not meet all the limitations of independent Claims 1, 10, 16, 25, and 26, which claims are therefore not disclosed by Onishi. Thus, the rejection under § 102(b) should be withdrawn as to these claims as well as to dependent Claims 2-9, 11-15, 17-21, and 27.

Claims 22 to 24 and 28 have been rejected under § 103(a) in view of Onishi and Culp. Each of these claims references an asymmetry element, and Culp was cited for its disclosure of an asymmetry element (in a piezocellular propulsion device). Claims 22 to

24 and 28 are dependent upon independent Claims 1, 10, 16, 25, and 26, claims that have been distinguished from Onishi above. The citation of Culp does not overcome the inherent deficiencies of Onishi as a reference against the independent claims and, by extension, as a reference against claims dependent on these independent claims. Therefore Claims 22 to 24 and 28 are patentable over the combination of Onishi and Culp, and the rejection under § 103(a) should be withdrawn.

Reconsideration and allowance of the claims herein are respectfully requested.

Respectfully submitted,

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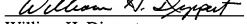

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